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# ENGINEERING SUPPORT PROGRAM

## W0-A-0061
## PRELIMINARY GEOLOGICAL DAM SITE ASSESSMENT REPORT BAMYAN PROVINCE

November 25, 2010

This publication was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech, Inc.

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**Principal Contacts:**


[redacted]
VP International Operations
Tetra Tech, Inc.
Washington, DC
[redacted]

[redacted]
Senior Vice President
Tetra Tech, Inc.
Framingham, MA
[redacted]

[redacted]
Project Manager
Tetra Tech, Inc.
Framingham, MA
[redacted]

[redacted]
Chief of Party
Tetra Tech, Inc.
Kabul, Afghanistan
[redacted]

TETRA TECH

November 25, 2010

[redacted] COTR
[redacted] ACOTR
USAID – Office of Infrastructure, Engineering, and Energy (OIEE)
Café Compound
U.S. Embassy
Great Masood Road, Kabul, Afghanistan

**Re: WO-A-0061**
**Preliminary Geological Dam Site Assessment Report**
**Bamyan Province**

[redacted]

In response to USAID's request, Tetra Tech has provided a preliminary geological assessment of six potential dam sites in Bamyan Province. This assessment was based on visual field evidence obtained by a Tetra Tech geologist while visiting each of the sites November 6-15, 2010. The attached report presents the data obtained, along with Tetra Tech's assessment of that information and subsequent conclusions.

Tetra Tech understands that the OIEE will incorporate the results of this preliminary geological dam site assessment report into an overall assessment report. It is understood that the OIEE is completing its own preliminary hydrological site assessment for the six potential dam sites. The subsequent complete report will be shared with RC-East, the Bamyan PRT, and ACEP for further consideration and action.

Tetra Tech will await your direction regarding proposed Long Term Work Order WO-LT-0027. That Work Order is intended to continue the field work investigation effort and design development of one or more of the dam sites investigated as part of this preliminary assessment report.

If you have questions or need additional information please do not hesitate to contact [redacted] in our office at [redacted].

Respectfully,

[redacted], P.E.
Chief of Party (OIEE-AESP)
Tetra Tech Inc.

Cc: [redacted], P.E. (USAID-OIEE)
[redacted] P.E. (USAID-OIEE)

# AFGHANISTAN ENGINEERING SUPPORT PROGRAM

WO-A-0061

## PRELIMINARY GEOLOGICAL DAM SITE ASSESSMENT REPORT BAMYAN PROVINCE

November 25, 2010

# Table of Contents

# 1.0 Introduction

In response to USAID's request, Tetra Tech conducted a preliminary geological assessment of six (6) potential dam sites located within the Bamyan Province of Central Afghanistan. The purpose of this assessment was to determine whether there are any obvious adverse geological foundation conditions which might preclude the construction of a dam at any of these sites. A Tetra Tech geologist visited each of the sites in November 2010 and performed field observations regarding the local topography, rock type and condition, and stream flow characteristics. The observed stream flows at this time of year are considered to be representative of the typical low-flow conditions in the watershed area. The observations, field data, and recommendations of the assessment are stated herein.

It should be noted that prior to the construction of any dam, a comprehensive program of subsurface investigation (i.e. rock coring) should be performed to determine the composition and condition of the rock not revealed by surface outcrops.

# 2.0 Background

USAID is currently performing feasibility-level studies for the design and construction of dams at six locations within Bamyan province. For the purpose of this assessment report, these sites are named as follows:

1. Fuladi Site 1
2. Kalu Site 1
3. Shikari Site 14
4. Shikari Site 12B
5. Shikari Site 11A
6. Tangi Ajar Site 1

It is noted that the original scope of work included two dam sites in addition to the six sites listed above: one at the north end of the Shikari Valley near Doyabe, and a second site near the west end of the Ajar Valley. Per instructions from the District Governor's security team, the team was instructed not to travel to Doyabe, due to security concerns. Also, the western Ajar Valley site assessment was cancelled by USAID representatives present during the field trip.

The six individual dam sites are proposed to serve as flood control, irrigation, and/or a source for hydro-power (HP) generation, depending on the respective locations.

Each of the six dam sites was visited by a Tetra Tech geologist. Field observations were recorded and data was collected, to determine if there were any obvious adverse geologic foundation conditions which would cause problems in the construction of a dam. In this report, each of the six sites is addressed individually except where information from another site is relevant (i.e. the three Shikari Valley sites). The limits of geologic assessment at each dam site includes a horizontal area approximately 25 meters (m) upstream and 25 m downstream of the proposed dam axis, and elevations up to approximately 50 m above the stream bed.

# 3.0 Fuladi Valley Site #1

## 3.1 Purpose of Dam

The dam proposed for this site is multi-purpose and would provide flood control, irrigation and power generation.

## 3.2 Location

This site is located approximately 12 km southwest of the town of Bamyan at the following coordinates:

Latitude: 34.765768 N
Longitude: 67.708759 E

(See maps below)


General Site Location Map


Site Aerial View

## 3.3 Topography

The Fuladi site is located in an approximately east-west trending valley (80°-260°), with stream flow to the west. The areas both above and below the proposed dam site are currently used for agriculture (potatoes), especially the southern valley wall.

The northern valley wall is steep, approaching vertical, and in places slightly overhanging. The wall has an approximate height of 22 m from streambed to the road surface. The surface of the wall is bare rock.

The southern wall is much more gently sloped, with terraced fields located from adjacent to the stream bank, to several hundred m outward from the bank. Due to the sloping nature of the wall, a total height measurement was not practical, other than to note it is greater than 50 m. The composition of the south wall is primarily overburden (sandy silt), with rock outcrops noted at the stream bed. Depth of overburden was estimated at greater than one meter.

The stream bed meanders moderately, indicating a fairly low energy regime. The low-flow, stream-top width was estimated at approximately 2.5 m to 3.0 m, with a depth ranging between 0.2 m and 0.4 m at the proposed site. The stream velocity (based on a timed chip log) was estimated to be approximately 0.7 meter per second (m/s). A stream bed consisting of exposed rock and well-rounded to sub-angular gravel-to-cobble-sized particles, was observed.

A local farmer was interviewed regarding historical stream stage data. Per his recollection, the water level has not risen more than 0.5 m above its present level in the last 20 years.

## 3.4 Geology

The rock outcrops observed are primarily light to medium tan limestone with areas of iron (hematite) staining. The majority of the rock face on the northern wall is covered with white to cream colored travertine and/or calcite deposits making identification of the underlying strata difficult. No preferred bedding planes were noted in the limestone (the overlying travertine deposits exhibited a sinuous stratigraphy). Observed jointing was minor, with random orientation. Joint gaps were noted to range up to 3 centimeters (cm), with infilling consisting of white calcite and/or travertine. No evidence of significant faulting was observed.

## 3.5 Summary

Based on the above data, there appears to be no significant geologic issues that will adversely impact the construction of a dam at this site.

## 3.6 Photographs


Looking north from top of south valley position

Looking southeast from south valley floor position


Looking west (up-valley) from top of south valley position


Looking down-valley (east) from top of south valley wall position


Small irrigation ditch located along base of south valley wall (looking southwest from south valley floor position)


Looking northwest from south valley floor position

# 4.0 Kalu Valley Site 1

## 4.1 Purpose of Dam

The dam proposed for this site is to provide power for a hydro-power generating facility.

## 4.2 Location

This site is located approximately 18 km east of the town of Bamyan at the following coordinates:

Latitude: 34.793584 N
Longitude: 68.004591 E

(See maps below)


General Site Location Map


Site Aerial View

## 4.3 Topography

The Kalu site is located in an approximately north-south trending valley (170°-350°), with stream flow to the north. No commercial or residential activities were apparent near the proposed dam site, other than the Pay-i-Mori school building, which is located on a shelf at the western valley side, approximately 200 m north of the proposed dam site.

Both valley walls are extremely steep (approaching vertical). The surfaces of the walls are bare rock with no talus or gravity debris present. The valley walls are approximately 15 m above the stream bed, where they transition into a flat area on either side (see attached photographs). The road surface is located on or above this flat section of the valley wall.

The stream bed exhibited minor meandering at the proposed dam site, indicating a moderate to fairly high energy regime. The low-flow stream top width was estimated to be 2.0 m to 3.0 m, with a depth ranging between 0.2 m and 1.1 m at the proposed site. A stream velocity (based on a timed chip log) was estimated to be 0.8 m/s. The observed stream bed consisted of exposed rock and well-rounded to sub-angular cobble-to-boulder- sized particles.

## 4.4 Geology

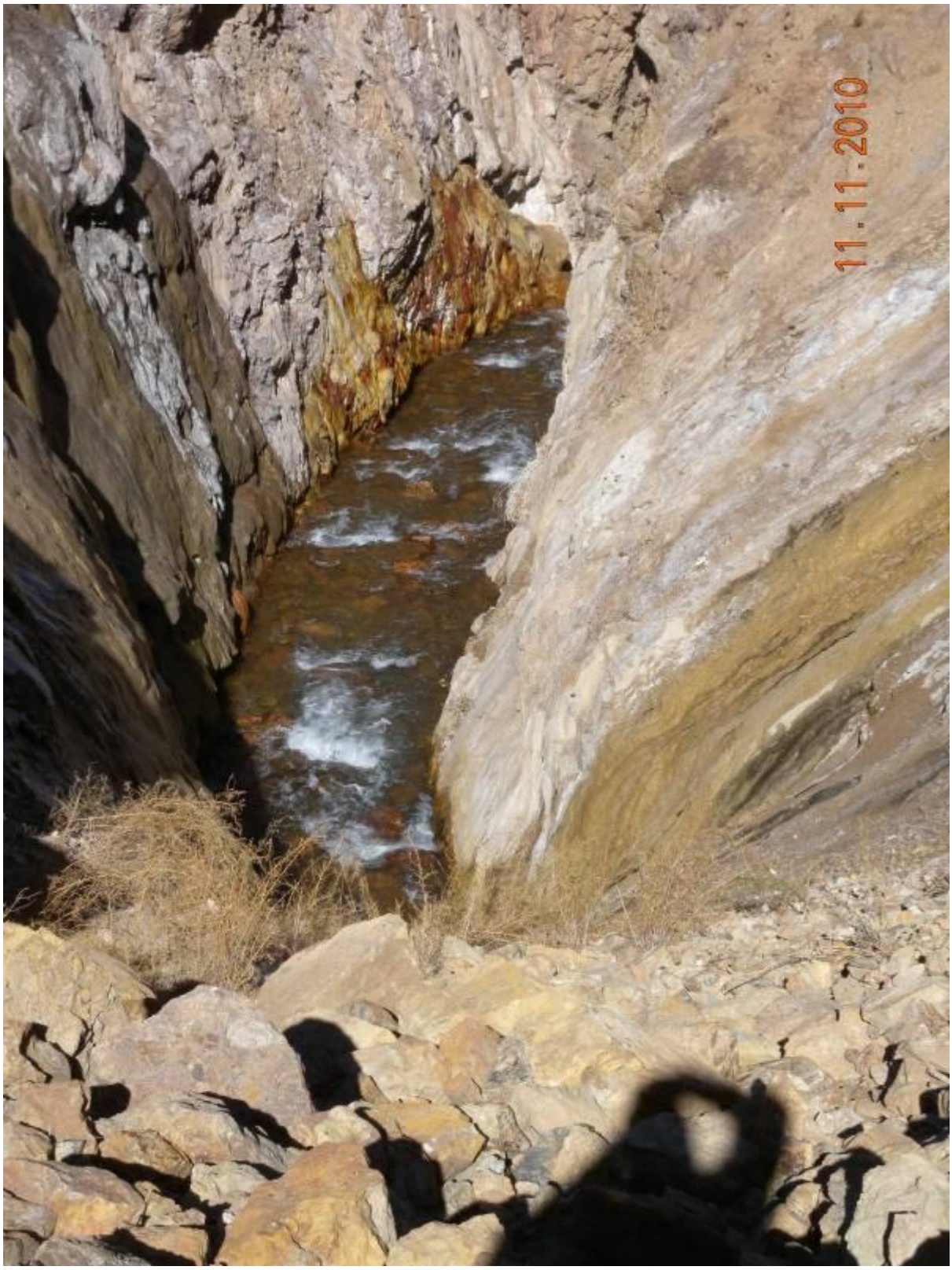
The rock outcrops observed are primarily medium to dark grey granite with reddish-brown to cream staining in areas. Extremely thick travertine and iron precipitate deposits (approximately 0.1 m to 0.3 m) were noted covering the eastern wall, making identification of the underlying strata difficult. There was evidence of warm seeps along the east wall as well. An area of medium-to-coarse grained reddish orange sandstone was noted underneath the travertine deposits on the east wall slightly downstream of the proposed dam axis. Due to the layer of travertine on the east wall face, no strike or dip measurements could be made. The general strike and dip of the west wall was recorded as 320°/15° E. The visible joints appeared random in orientation. Joint gaps were observed to be tight, with little or no infilling. No evidence of significant faulting was observed.

## 4.5 Summary

Based on the above data, there appears to be no significant geologic issues that will adversely impact the construction of a dam at this site, although a more thorough investigation into the warm seeps might indicate possible structural compromise of the underlying rock structure.

## 4.6 Photographs


Looking south (upstream) from east bank position




Looking north (downstream) from upstream position


Looking south from east bank position (travertine deposits)


Looking north from east bank position


Looking north (downstream) from west bank position (Pay-i-Mori School in background)


Looking downstream (north) from west bank (Pay-i-Mori School in background)

# 5.0 Shikari Site 14

## 5.1 Purpose of Dam

A low-head dam is proposed for this site. It would be part of a series of cascading dams to provide power for a hydro-power generating facility.

## 5.2 Location

This site is located approximately 21 km northeast of the town of Bamyan at the following coordinates:

Latitude: 34.89818 N
Longitude: 68.036932 E

(See maps below)


General Site Location Map


Site Aerial View

## 5.3 Topography

The Shikari Site 14 is the most southerly site of the Shikari Valley sites that were assessed, and is located at the southern end of the Shikari Valley. The valley orientation is approximately north-south (330°- 150°), with stream flow to the north. No commercial or residential activities were observed near the proposed dam site.

Both valley walls are very steep (within 20° of vertical), with the eastern wall slightly less steep than the western wall. The road is situated at the eastern side of the stream, abutting the eastern stream bank. The elevation difference from the stream bed to the road surface was approximately 2.5 m at the observed location. A manmade rock wall acts as a road support and provides bank erosion protection. The valley walls ultimately extend more than 50 m above the stream bed on either side. The surfaces of the walls are exposed rock. A moderate accumulation of talus was evident at the bottom of the western valley wall.

The stream bed exhibited minor meandering at the proposed dam site, indicating a moderate to fairly high energy regime. The low-flow stream top width was estimated to be 12 m, with a depth ranging between 0.2 m and 0.8 m at the proposed site. A stream velocity (based on a timed chip log) was estimated to be 1.0 m/s. The observed stream bed consisted of exposed rock and well-rounded-to-angular, gravel-to-boulder-sized particles. A small deposit of fine

to coarse grained sand approximately 0.3 m wide was noted along the eastern edge of the stream bank

## 5.4 Geology

The rock outcrops observed are primarily medium to dark grey-green granite. Strike and dip of the massively bedded rock was recorded as 140°/10°E. Jointing was minor and in random orientation. Joint gaps appeared to be tight, although one joint was observed to have a gap of approximately 1 cm, infilled with calcite or travertine. No evidence of significant faulting was observed.

## 5.5 Summary

Based on the above data, there appears to be no significant geologic issues that would adversely impact the construction of a low-head dam at this site.

## 5.6 Photographs


Looking north (downstream) from east bank position


Looking northwest from east bank position


Looking north from the east bank position


Looking west from east bank position. (Note existing irrigation canal.)

# 6.0 Shikari Site 12B

## 6.1 Purpose of Dam

The dam proposed for this site is a low head dam and would be a part of a series of cascading dams to provide power for a hydro-power generating facility.

## 6.2 Location

This site is located approximately 21 km northeast of the town of Bamyan at the following coordinates:

Latitude: 34.913723 N
Longitude: 68.025347 E

(See maps below)


General Site Location Map


Site Aerial View

## 6.3 Topography

The Shikari Site 12B is located at the southern end of the Shikari Valley, and is oriented approximately east-west (300°-120°), with stream flow to the west. No commercial or residential activities were observed near the proposed dam site.

The valley topography is similar to the Shikari 14 Site. Both valley walls are extremely steep, with the western wall nearly vertical, and the eastern wall slightly less steep. The road is located on the northern side of the stream, abutting the northern stream bank. The elevation difference from the stream bed to the road surface was estimated to be 2.0 m and is comprised of a manmade rock wall, which acts as road support and bank reinforcement. The valley walls extend more than 50 m above the stream bed. The surfaces of the walls are exposed rock. A moderate accumulation of talus was evident at the bottom of the southern slope.

The stream channel exhibited minor meandering at the proposed dam site, indicating a moderate to fairly high energy regime. The low-flow stream top width was estimated to be 21 m, with a depth ranging between 0.2 m and 0.5 meter at the proposed site. A stream velocity (based on a timed chip log) was estimated to be 0.6 m/s. The observed stream bed consisted of exposed rock and well-rounded-to-angular, gravel-to-boulder-sized particles.

## 6.4 Geology

The rock outcrops observed are primarily medium brown to tan granite. No preferential bedding planes were noted and so no strike or dip measurements were recorded. Jointing appeared to be minor and in random orientation. Joint widths appeared to be tight with no infilling observed. No evidence of significant faulting was observed.

## 6.5 Summary

Based on the above data, there appears to be no significant geologic issues that would adversely impact the construction of a low head dam at this site.

## 6.6 Photographs


Looking east (upstream) from the north bank position


Looking south from north bank position


Looking west (downstream) from north bank position

# 7.0 Shikari Site 11A

## 7.1 Purpose of Dam

The dam proposed for this site is a low-head dam and would be a part of a series of cascading dams to provide power for a hydro-power generating facility.

## 7.2 Location

This site is located approximately 22 km northeast of the town of Bamyan at the following coordinates:

Latitude: 34.949440 N
Longitude: 68.011080 E

(See maps below)


General Site Location Map


Site Aerial View

## 7.3 Topography

The Shikari Site 11A is located at the southern end of the Shikari Valley (but north of the Shikari 14 and Shikari 12B sites), and is oriented approximately northwest-southeast (310°-130°), with stream flow to the northwest. No commercial or residential activities were observed near the proposed dam site.

Both valley walls are close to vertical. The road is located on the northeastern side of the stream, abutting the northeastern stream bank. The elevation difference from the stream bed to the road surface was estimated to be 1.5 m. The valley walls extend more than 50 m above the stream bed. The surfaces of the walls are bare rock. A small accumulation of talus was evident at the bottom of the southwestern slope. The stream bed exhibited minor meandering at the proposed dam site, indicating a moderate to fairly high energy regime. The low-flow stream width was estimated to be 10 m, with a depth ranging between 0.2 m and 1.5 m at the proposed site. A stream velocity (based on a timed chip log) was estimated to be 0.9 m/s. The observed stream bed consisted of clean rock, covered with well-rounded-to-angular, gravel-to- boulder-sized particles.

## 7.4 Geology

The rock outcrops observed are primarily medium to dark brown to dark grey granite. Strike and dip of the massively bedded rock was recorded as 120°/15° E. Jointing appeared to be minor and in random orientation. Joint widths appeared to be tight, with trace amounts of calcite/travertine. No evidence of significant faulting was observed.

## 7.5 Summary

Based on the above data, there appears to be no significant geologic issues that would adversely impact the construction of a dam foundation at this site.

## 7.6 Photographs


Looking south (downstream) from northeast bank position


Looking southwest from northeast bank position


Looking southeast (upstream) from northeast bank position

# 8.0 Tangi Ajar Site 1

## 8.1 Purpose of Dam

The dam proposed for this site is multi-purpose and would provide flood control, irrigation and power generation.

## 8.2 Location

This site is located approximately 60 km northwest of the town of Bamyan at the following coordinates:

Latitude: 34.949440 N
Longitude: 68.011080 E

(See maps below)


General Site Location Map


Site Aerial View

## 8.3 Topography

The Tangi Ajar Site 1 is located at the eastern end of the Ajar Valley, and is oriented approximately northwest-southeast (290°-110°), with stream flow to the northwest. No commercial or residential activities were observed near the proposed dam site.

Both valley walls are steep. The road is located on the northeastern side of the stream, abutting the stream bank. The elevation difference from the stream bed to the road surface was estimated to be 1.3 m at the observed location. The valley walls extend more than 50 m above the stream bed. The surfaces of the walls are bare rock. A moderate accumulation of talus was observed at the bottom of the southwestern valley wall. The stream bed exhibited moderate meandering and some braiding at the proposed dam site, indicating a fairly low energy regime. The low-flow stream width was estimated to be 4 m, with a depth ranging between 0.2 m and 1.2 m at the proposed site. A stream velocity (based on a timed chip log) was estimated to be 0.6 m/s. The observed stream bed consisted of clean rock, covered with well-rounded-to-angular, gravel-to-boulder-sized particles.

## 8.4 Geology

The rock outcrops are primarily medium grey to tan limestone. Strike and dip of the massively bedded rock was recorded as 350°/30°W. Visible jointing was minor, with no preferred orientation. Joint gaps appeared to be tight, with only minor infilling noted. No evidence of significant faulting was observed.

## 8.5 Summary

Based on the above data, there appears to be no significant geologic issues that would adversely impact the construction of a dam at this site.

## 8.6 Photographs


Looking south (upstream) from northeast bank position


Looking northwest from high northeast bank position


Looking northeast from northeast valley floor position


Looking northeast from mid-height northeast valley position

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U.S. Embassy Cafe Compound
Great Masood Road
Kabul, Afghanistan
Tel: 202.216.6288
**http://afghanistan.usaid.gov**